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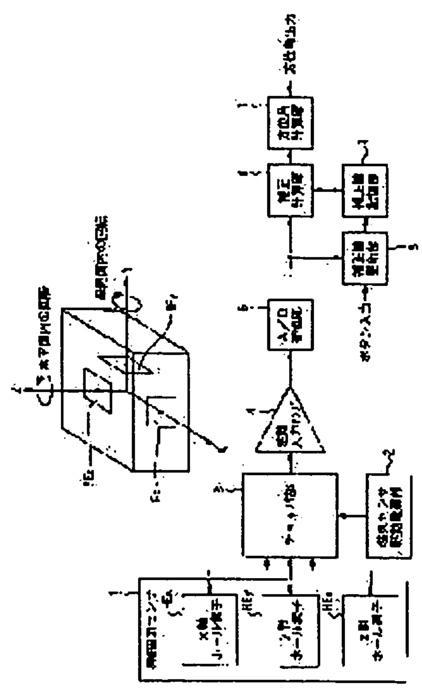
(54) AZIMUTH MEASURING APPARATUS, CALIBRATION METHOD, AND CALIBRATION PROGRAM

(57)Abstract:

PROBLEM TO BE SOLVED: To perform a calibration of a magnetic sensor with a high precision without depending on a rotational speed.

SOLUTION: When each of an x axis Hall element HEx. y axis Hall element HEy, and z axis Hall element HEz is rotated in each predetermined plane 90° by 90° or 180° by 180°, based on the output amplified value of the x axis Hall element HEx, that of y axis Hall element HEy, and that of z axis Hall element HEz, the present offset value and sensitive value of the x axis Hall element HEx, the y axis Hall element HEy, and the z axis Hall element HEz are updated.



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CLAIMS

[Claim(s)]
[Claim 1]
The magnetometric sensor more than biaxial [which detects earth magnetism],
The offset information storage section which memorizes the offset information over each brake horsepower of said magnetometric sensor,
The amendment count section which amends the output of said magnetometric sensor based on said offset information,
The azimuth count section which calculates bearing based on the output correction value by said amendment count section,
The azimuth metering device characterized by having the renewal section of offset information which updates the offset information over each brake horsepower of said magnetometric sensor based on the output of said magnetometric sensor acquired at spacing which at least one or more shafts rotate 180 degrees among the shafts with which said magnetometric sensor detects earth magnetism.
[Claim 2]
The magnetometric sensor more than biaxial [which detects earth magnetism],
The sensibility information storage section which memorizes the sensitivity information over each brake horsepower of said magnetometric sensor,
The amendment count section which amends the output of said magnetometric sensor based on said sensitivity information,
The azimuth count section which calculates bearing based on the output correction value by said amendment count section,
The azimuth metering device characterized by having the renewal section of sensitivity information which updates the sensitivity information over each brake horsepower of said magnetometric sensor based on the output of said magnetometric sensor acquired at spacing which at least one or more shafts rotate 90 degrees among the shafts with which said magnetometric sensor detects earth magnetism.
[Claim 3]
The magnetometric sensor more than biaxial [which detects earth magnetism],
The offset information storage section which memorizes the offset information over each brake horsepower of said magnetometric sensor updated based on the output of said magnetometric sensor,
It has the desorption wearing means which enables a pocket device to desorption wearing of the part of said magnetometric sensor at least,
Said offset information storage section is an azimuth metering device characterized by having memorized said offset information also in the condition that the part of said magnetometric sensor was desorbed from the pocket device.
[Claim 4]
The magnetometric sensor more than biaxial [which detects earth magnetism],
The offset information storage section which memorizes the offset information over each brake horsepower of said magnetometric sensor,

The amendment count section which amends the output of said magnetometric sensor based on said offset information,
The angle-of-deviation information acquisition section which acquires the magnetic declination information in a its present location,
The azimuth count section which calculates bearing based on the output correction value by said amendment count section,
The display which displays the map information on a its present location on the display screen,
The display and control section which indicates said map information by rotation so that it may be in agreement with either of the shafts with which the east and west on the earth magnetism of said map information detect the earth magnetism in said magnetometric sensor,
The azimuth metering device characterized by having the renewal section of offset information which updates the offset information over each brake horsepower of said magnetometric sensor based on the output of said magnetometric sensor when rotating said magnetometric sensor so that the sense of the map information on the present location displayed on said display screen may be in agreement with the sense of the scene of a its present location.
[Claim 5]
The magnetometric sensor more than biaxial [which detects earth magnetism],
The offset information storage section which memorizes the offset information over each brake horsepower of said magnetometric sensor,
The amendment count section which amends the output of said magnetometric sensor based on said offset information,
The angle-of-deviation information acquisition section which acquires the magnetic declination information in a its present location,
The azimuth count section which calculates bearing based on the output correction value by said amendment count section,
The display which displays the map information on a its present location on the display screen,
The display and control section which indicates said map information by rotation so that it may be in agreement with either of the shafts with which the east and west on the earth magnetism of said map information detect the earth magnetism in said magnetometric sensor,
The roll control section which rotates the map information currently displayed on said display at intervals of 90 degrees or 180 degrees,
The azimuth metering device characterized by have the offset / renewal section of sensitivity information of the offset information or sensitivity information over each brake horsepower of said magnetometric sensor which update either at least based on the output of said magnetometric sensor when rotate said magnetometric sensor so that the sense of the map information on the its present location displayed on said display screen may be in agreement with the sense of the scene of a its present location .
[Claim 6]
The step which makes the output of said magnetometric sensor memorize where the sensor module with which the magnetometric sensor for detecting the angle of rotation within a flat surface was carried is maintained in said flat surface,
The step which rotates said sensor module only 180 degrees in said flat surface from the first location, and makes the output of said magnetometric sensor memorize,
The calibration approach characterized by having the step which updates the offset value of said magnetometric sensor based on the subtraction result of the output value of said magnetometric sensor memorized in the first location, and the output value of said magnetometric sensor memorized in the location rotated only 180 degrees.
[Claim 7]
The step which makes the output of said magnetometric sensor memorize where the sensor module with which the magnetometric sensor for detecting the angle of rotation within a flat surface was carried is maintained in said flat surface,

The step which rotates said sensor module only 90 degrees in said flat surface from the first location, and makes the output of said magnetometric sensor memorize,
The step which rotates said sensor module only 180 degrees in said flat surface from the first location, and makes the output of said magnetometric sensor memorize,
The step which updates the offset value of said magnetometric sensor based on the subtraction result of the output value of said magnetometric sensor memorized in the first location, and the output value of said magnetometric sensor memorized in the location rotated only 180 degrees,
The calibration approach characterized by having the step which updates the sensitivity information of said magnetometric sensor based on the sum of squares with the value which subtracted said offset value from the value which subtracted said offset value from the output value of said magnetometric sensor memorized in the first location, and the output value of said magnetometric sensor memorized in the location rotated only 90 degrees.
[Claim 8]
The step which displays the map information on a its present location on said display screen so that it may be in agreement with the 1st shaft with which the east and west on earth magnetism detect the earth magnetism in a magnetometric sensor,
The step which rotates a magnetometric sensor so that the sense of the map information on the present location displayed on said display screen may be in agreement with the sense of the scene of a its present location,
The step which makes the output of said magnetometric sensor when the sense of said map information is in agreement with the sense of said scene memorize,
The step which rotates the map information on the present location currently displayed on said display screen so that it may be in agreement with the 2nd shaft with which the east and west on earth magnetism detect the earth magnetism in a magnetometric sensor,
The step which rotates said magnetometric sensor so that the sense of the map information on the present location by which it was indicated by rotation so that it might be in agreement with said 2nd shaft in said display screen may be in agreement with the sense of the scene of a its present location,
The step which makes the output of said magnetometric sensor when the sense of the map information by which it was indicated by rotation so that it might be in agreement with said 2nd shaft in said display screen is in agreement with the sense of said scene memorize,
The calibration approach characterized by having the step of the offset information on said magnetometric sensor, or sensitivity information which updates either at least based on the output value of said magnetometric sensor memorized in the first location, and the output value of said magnetometric sensor memorized in the 2nd location.
[Claim 9]
The step which acquires each brake horsepower of the magnetometric sensor which at least one or more shafts rotated at intervals of 90 degrees or 180 degrees among the shafts with which a magnetometric sensor detects earth magnetism,
The calibration program characterized by making a computer perform the step of the offset information over each brake horsepower of said magnetometric sensor, or sensitivity information which updates either at least based on each brake horsepower of said acquired magnetometric sensor.
[Claim 10]
The step which displays the map information on a its present location on said display screen so that it may be in agreement with the 1st shaft with which the east and west on earth magnetism detect the earth magnetism in a magnetometric sensor,
The calibration program characterized by having the step of the offset information on said magnetometric sensor, or sensitivity information which updates either at least based on the output of said magnetometric sensor when said magnetometric sensor rotates so that the sense of the map information on the present location displayed on said display screen may be in agreement with the sense of the scene of a its present location.

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
About an azimuth metering device, the calibration approach, and a calibration program, especially this invention is applied, when amending offset and sensibility ratio of a magnetometric sensor, and it is suitable.
[0002]
[Description of the Prior Art]
If the conventional magnetometric sensor is carried in the interior of a pocket device, since the magnetic field to which it leaks from a near loudspeaker, the magnetized electronic parts of a metal package exists, the magnetic field resulting from the interior of these pocket device is outputted as a signal of said magnetometric sensor.
Consequently, in the azimuth metering device which carries a magnetometric sensor in a pocket device and detects earth magnetism, since the magnetic field resulting from the interior of said pocket device serves as offset over earth magnetism, the measurement precision of an azimuth may deteriorate.
[0003]
And the calibration to which the magnetic field resulting from the interior of said pocket device amends offset fluctuation of a magnetometric sensor in the conventional azimuth metering device since reinforcement and a direction change with a temperature change or aging is performed.
Drawing 14 is a flow chart which shows the calibration approach of the conventional azimuth metering device.
[0004]
In drawing 14 , the calibration initiation carbon button of a mobile equipment is pushed (step S121).
And a mobile equipment is slowly rotated 1 round or more at uniform velocity, keeping level the mobile equipment in which the magnetometric sensor of the X-axis and a Y-axis was carried (step S122).
And if a mobile equipment is rotated 1 round or more, the calibration termination carbon button of a mobile equipment will be pushed (step S123: this step can be skipped).
[0005]
The calibration to the magnetometric sensor of the X-axis and each Y-axis can be performed by making into offset information the value which made the value which detected the maximum and the minimum value of a signal output in the magnetometric sensor of the X-axis and each Y-axis, subtracted the value, and was divided by 2 the sensitivity information of a magnetometric sensor, respectively, added it, and was divided by 2 here, while rotating a mobile equipment 1 round or more.
[0006]
[Problem(s) to be Solved by the Invention]
however, by the conventional calibration approach If it is necessary to rotate a mobile equipment 1 round or more on a flat surface and the rotational speed of a mobile equipment is too quick in order to calculate the current maximum of a magnetometric sensor, and the minimum value Maximum and the

minimum value will be overlooked, and when too conversely late, there was a problem that calibration precision deteriorated or it became calibration impossible that the number of reading data is huge and memory overflows etc. when it separates from the range where rotational speed is fixed.
[0007]
For this reason, the user repeated trial-and-error, by the time the calibration was successful, and he was required as rotating a mobile equipment repeatedly.
Then, the purpose of this invention is offering the azimuth metering device which can perform the calibration of a magnetometric sensor with a sufficient precision, the calibration approach, and a calibration program, without being dependent on rotational speed.
[0008]
[Means for Solving the Problem]
In order to solve the technical problem mentioned above, according to the azimuth metering device according to claim 1 The magnetometric sensor more than biaxial [which detects earth magnetism], and the offset information storage section which memorizes the offset information over each brake horsepower of said magnetometric sensor, The amendment count section which amends the output of said magnetometric sensor based on said offset information, The azimuth count section which calculates bearing based on the output correction value by said amendment count section, It is characterized by having the renewal section of offset information which updates the offset information over each brake horsepower of said magnetometric sensor based on the output of said magnetometric sensor acquired at spacing which at least one or more shafts rotate 180 degrees among the shafts with which said magnetometric sensor detects earth magnetism.
[0009]
This becomes possible [computing the current offset information on a magnetometric sensor] by collecting the outputs of a magnetometric sensor twice at intervals of 180 rotations.
For this reason, it becomes possible to perform the calibration of a magnetometric sensor with a sufficient precision, without it becoming unnecessary to rotate a mobile equipment at uniform velocity, and being dependent on rotational speed, in order to compute the current offset information on a magnetometric sensor.
[0010]
Moreover, the magnetometric sensor more than biaxial [which detects earth magnetism according to the azimuth metering device according to claim 2], The sensibility information storage section which memorizes the sensitivity information over each brake horsepower of said magnetometric sensor, The amendment count section which amends the output of said magnetometric sensor based on said sensitivity information, The azimuth count section which calculates bearing based on the output correction value by said amendment count section, It is characterized by having the renewal section of sensitivity information which updates the sensitivity information over each brake horsepower of said magnetometric sensor based on the output of said magnetometric sensor acquired at spacing which at least one or more shafts rotate 90 degrees among the shafts with which said magnetometric sensor detects earth magnetism.
[0011]
This becomes possible [computing the current sensitivity information of a magnetometric sensor] by collecting the outputs of a magnetometric sensor twice [at least] at intervals of 90 rotations.
For this reason, it becomes possible to perform the calibration of a magnetometric sensor with a sufficient precision, without it becoming unnecessary to rotate a mobile equipment at uniform velocity, and being dependent on rotational speed, in order to compute the current sensitivity information of a magnetometric sensor.
Moreover, the magnetometric sensor more than biaxial [which detects earth magnetism according to the azimuth metering device according to claim 3], The offset information storage section which memorizes the offset information over each brake horsepower of said magnetometric sensor updated based on the output of said magnetometric sensor, It has the desorption wearing means which enables a pocket device to desorption wearing of the part of said magnetometric sensor at least, and said offset

information storage section is characterized by having memorized said offset information also in the condition that the part of said magnetometric sensor was desorbed from the pocket device.
[0012]
This becomes possible to post-install an azimuth metering device in a terminal, and an azimuth measurement function can be added to a terminal, making possible the calibration of the offset generated at the time of wearing, when a terminal is not equipped with the azimuth measurement function.
Moreover, the magnetometric sensor more than biaxial [which detects earth magnetism according to the azimuth metering device according to claim 4], The offset information storage section which memorizes the offset information over each brake horsepower of said magnetometric sensor, The amendment count section which amends the output of said magnetometric sensor based on said offset information, The angle-of-deviation information acquisition section which acquires the magnetic declination information in a its present location, and the azimuth count section which calculates bearing based on the output correction value by said amendment count section, So that it may be in agreement with the display which displays the map information on a its present location on the display screen, and either of the shafts with which the east and west on the earth magnetism of said map information detect the earth magnetism in said magnetometric sensor So that the sense of the map information on the display and control section which indicates said map information by rotation, and the present location displayed on said display screen may be in agreement with the sense of the scene of a its present location It is characterized by having the renewal section of offset information which updates the offset information over each brake horsepower of said magnetometric sensor based on the output of said magnetometric sensor when rotating said magnetometric sensor.
[0013]
Thereby, the magnetosensitive shaft of a magnetometric sensor can be changed into the condition that it becomes horizontally possible to turn to east and west, and there is almost no earth magnetism, using a map.
For this reason, it becomes possible to substitute for one measurement the offset calibration of the magnetometric sensor which has turned to the direction of east and west, and it becomes possible to facilitate a calibration activity.
[0014]
Moreover, the magnetometric sensor more than biaxial [which detects earth magnetism according to the azimuth metering device according to claim 5], The offset information storage section which memorizes the offset information over each brake horsepower of said magnetometric sensor, The amendment count section which amends the output of said magnetometric sensor based on said offset information, The angle-of-deviation information acquisition section which acquires the magnetic declination information in a its present location, and the azimuth count section which calculates bearing based on the output correction value by said amendment count section, So that it may be in agreement with the display which displays the map information on a its present location on the display screen, and either of the shafts with which the east and west on the earth magnetism of said map information detect the earth magnetism in said magnetometric sensor The display and control section which indicates said map information by rotation, and the roll control section which rotates the map information currently displayed on said display at intervals of 90 degrees or 180 degrees, So that the sense of the map information on the present location displayed on said display screen may be in agreement with the sense of the scene of a its present location Based on the output of said magnetometric sensor when rotating said magnetometric sensor, it is characterized by having the offset / renewal section of sensitivity information of the offset information or sensitivity information over each brake horsepower of said magnetometric sensor which updates either at least.
[0015]
In case the magnetometric sensor magnetosensitive shaft of eye one shaft is set by east and west and the offset is measured by this In case the magnetometric sensor output of another biaxial eye is memorized, then the magnetometric sensor magnetosensitive shaft of a biaxial eye is set by east and west and the offset is measured, by performing measurement of memorizing the magnetometric sensor output of eye

one shaft The calibration to four of biaxial offset information and sensitivity information can be terminated only by two measurement.

[0016]

According to the calibration approach according to claim 6, the sensor module with which the magnetometric sensor for detecting the angle of rotation within a flat surface was carried in moreover, the condition of having maintained in said flat surface The step which makes the output of said magnetometric sensor memorize, and the step which rotates said sensor module only 180 degrees in said flat surface from the first location, and makes the output of said magnetometric sensor memorize, It is characterized by having the step which updates the offset value of said magnetometric sensor based on the subtraction result of the output value of said magnetometric sensor memorized in the first location, and the output value of said magnetometric sensor memorized in the location rotated only 180 degrees.

[0017]

Thereby, it starts from the location of the arbitration within a flat surface, and the sense is changed only 180 degrees and it becomes possible by collecting the outputs of a magnetometric sensor to compute the current offset information on a magnetometric sensor.

For this reason, it becomes possible to perform the calibration of a magnetometric sensor with a sufficient precision, using human being's sense of direction effectively, becoming possible to collect the outputs of a magnetometric sensor, and mitigating a user's burden.

[0018]

According to the calibration approach according to claim 7, the sensor module with which the magnetometric sensor for detecting the angle of rotation within a flat surface was carried in moreover, the condition of having maintained in said flat surface The step which makes the output of said magnetometric sensor memorize, and the step which rotates said sensor module only 90 degrees in said flat surface from the first location, and makes the output of said magnetometric sensor memorize, The step which rotates said sensor module only 180 degrees in said flat surface from the first location, and makes the output of said magnetometric sensor memorize, The step which updates the offset value of said magnetometric sensor based on the subtraction result of the output value of said magnetometric sensor memorized in the first location, and the output value of said magnetometric sensor memorized in the location rotated only 180 degrees, The value which subtracted said offset value from the output value of said magnetometric sensor memorized in the first location, It is characterized by having the step which updates the sensitivity information of said magnetometric sensor based on the sum of squares with the value which subtracted said offset value from the output value of said magnetometric sensor memorized in the location rotated only 90 degrees.

[0019]

Thereby, it starts from the location of the arbitration within a flat surface, and the sense is changed only 90 degrees and 180 degrees, and it becomes possible by collecting the outputs of a magnetometric sensor to compute the current offset information and the sensitivity information of a magnetometric sensor.

For this reason, it becomes possible to perform the calibration of a magnetometric sensor with a sufficient precision, using human being's sense of direction effectively, becoming possible to collect the outputs of a magnetometric sensor, and mitigating a user's burden.

[0020]

Moreover, so that it may be in agreement with the 1st shaft with which the east and west on earth magnetism detect the earth magnetism in a magnetometric sensor according to the calibration approach according to claim 8 So that the sense of the map information on the step which displays the map information on a its present location on said display screen, and the present location displayed on said display screen may be in agreement with the sense of the scene of a its present location So that it may be in agreement with the step turning around a magnetometric sensor, the step which makes the output of said magnetometric sensor when the sense of said map information is in agreement with the sense of said scene memorize, and the 2nd shaft with which the east and west on earth magnetism detect the earth magnetism in a magnetometric sensor So that the sense of the map information on the step which rotates

the map information on the present location currently displayed on said display screen, and the present location by which it was indicated by rotation so that it might be in agreement with said 2nd shaft in said display screen may be in agreement with the sense of the scene of a its present location The step which makes the output of said magnetometric sensor when the sense of the step turning around said magnetometric sensor and the map information by which it was indicated by rotation so that it might be in agreement with said 2nd shaft in said display screen is in agreement with the sense of said scene memorize, Based on the output value of said magnetometric sensor memorized in the first location, and the output value of said magnetometric sensor memorized in the 2nd location, it is characterized by having the step of the offset information on said magnetometric sensor, or sensitivity information which updates either at least.

[0021]

It becomes possible to perform the calibration of a magnetometric sensor with a sufficient precision, becoming possible to substitute the count of collection of the output of a magnetometric sensor for 2 times, and mitigating a user's burden, when performing the calibration of both the offset information on a magnetometric sensor, and sensitivity information, while this becomes possible to change the sense of a magnetometric sensor on the basis of the scene of a its present location.

[0022]

Moreover, according to the calibration program according to claim 9, it is characterized by making a computer perform the step which acquires each brake horsepower of the magnetometric sensor which at least one or more shafts rotated at intervals of 90 degrees or 180 degrees among the shafts with which a magnetometric sensor detects earth magnetism, and the step of offset information [as opposed to each brake horsepower of said magnetometric sensor based on said each acquired brake horsepower of a magnetometric sensor], or sensitivity information which updates either at least.

[0023]

It becomes possible to perform the calibration of a magnetometric sensor with a sufficient precision, without becoming possible [without rotating a mobile equipment at uniform velocity] to compute either [at least] the current offset information on a magnetometric sensor, or sensitivity information, and being dependent on rotational speed by installing a calibration program in a mobile equipment, by this.

[0024]

Moreover, so that it may be in agreement with the 1st shaft with which the east and west on earth magnetism detect the earth magnetism in a magnetometric sensor according to the calibration program according to claim 10 So that the sense of the map information on the step which displays the map information on a its present location on said display screen, and the present location displayed on said display screen may be in agreement with the sense of the scene of a its present location Based on the output of said magnetometric sensor when said magnetometric sensor rotates, it is characterized by having the step of the offset information on said magnetometric sensor, or sensitivity information which updates either at least.

[0025]

Thereby, the magnetosensitive shaft of a magnetometric sensor can be changed into the condition that it becomes horizontally possible to turn to east and west, and there is almost no earth magnetism, by installing a calibration program in a mobile equipment using a map.

For this reason, it becomes possible to substitute for one measurement the offset calibration of the magnetometric sensor which has turned to the direction of east and west, and it becomes possible to facilitate a calibration activity.

[0026]

[Embodiment of the Invention]

Hereafter, the azimuth metering device and the calibration approach concerning the operation gestalt of this invention are explained, referring to a drawing.

Drawing 1 is the block diagram showing the outline configuration of the azimuth metering device concerning the 1st operation gestalt of this invention.

[0027]

In drawing 1 , 3 shaft magnetometric sensor 1, the magnetometric sensor drive power supply section 2, the chopper section 3, the difference input amplifier 4, the A/D-conversion section 5, the amendment count section 6, the azimuth count section 7, the renewal section 8 of correction value, and the correction value storage section 9 are formed in an azimuth metering device, and x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz are formed in 3 shaft magnetometric sensor 1.

[0028]
Here, x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz are arranged in the sensor module SM, the x-axis hall device HEx and the y-axis hall device HEy are arranged so that the angle of rotation within a horizontal plane may be detected, and the z-axis hall device HEz is arranged so that the MAG of the direction of a vertical may be detected.
In addition, as for x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, it is desirable that it is for detecting earth magnetism, for example, they are a compound semiconductor system or Si monolithic systems, such as InSb, and InAs, GaAs.
[0029]
The chopper section 3 is for switching the terminal which drives x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, respectively, and impresses the driver voltage outputted from the magnetometric sensor drive power supply section 2, respectively to x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz.
Here, for example, 90-degree chopper drive, 360-degree chopper drive, etc. can be used for the chopper section 3. In addition, in 90-degree chopper drive, in case x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz are driven, most own offset terms of a hall device contained in the output of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz can be canceled.
[0030]
Moreover, in 360-degree chopper drive, not only the own offset term of a hall device contained in the output of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz but the electric offset term by difference input amplifier 4 latter self is easily cancellable.
Next, the signal outputted from x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz is inputted into the amendment count section 6 after the output magnification value which was amplified, respectively and was amplified with the difference input amplifier 4 here is changed into a digital signal in the A/D-conversion section 5.
[0031]
Here, the offset value and sensibility value of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz are memorized, respectively, and by using these offset values and a sensibility value, in the correction value storage section 9, the amendment count section 6 amends the output magnification value of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, respectively, and takes out only the values alpha, beta, and gamma proportional to each axial component of earth magnetism in it.
[0032]
Here, the renewal section 8 of correction value acquires the output magnification value from x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz when rotating x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz in a predetermined side, respectively. And based on the output magnification value from that of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, the current offset value and current sensibility value of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz are computed, respectively, and the offset value and sensibility value which are memorized by the correction value storage section 9 are updated.
[0033]
In the amendment count section 6, if the values alpha, beta, and gamma proportional to each axial component of earth magnetism are taken out, these values alpha, beta, and gamma will be outputted to

the azimuth count section 7.
And for example, when the X-axis and a Y-axis are in a horizontal plane, the azimuth count section 7 computes Azimuth theta based on the sign of the values alpha and beta proportional to each axial component of earth magnetism, and the formula of theta=arcTAN (beta/alpha).
[0034]
Moreover, Azimuth theta is also computable after amending a tilt angle using the values alpha, beta, and gamma proportional to each axial component of earth magnetism, when the X-axis and a Y-axis lean from the horizontal plane.
Here, the renewal section 8 of correction value acquires the signal Xi from the x-axis hall device HEx by the carbon button input at the time of a pocket device being rotated by a unit of 90 degrees twice or more in the same field, when updating the offset value and sensibility value of the x-axis hall device HEx which are memorized by the correction value storage section 9.
[0035]
And the present offset value Offsetx of the x-axis hall device HEx and the sensibility value Amplitudex can be calculated by applying the following formulas (1-1) and a formula (1-2).
About the y-axis hall device HEy and the z-axis hall device HEz, the present offset values Offsety and Offsetz and the sensibility values Amplitudey and Amplitudez can be calculated similarly, respectively.
[0036]
[Equation 1]

$$\mathrm{Offset}_x = (X_\theta + X_{\theta+180^\circ})/2 \quad \cdots \quad (1\text{-}1)$$

[0037]
[Equation 2]

$$\mathrm{Amplitude}_x = \sqrt{\{(X_\theta - \mathrm{Offset}_x)^2 + (X_{\theta+90^\circ} - \mathrm{Offset}_x)^2\}} \quad \cdots \quad (1\text{-}2)$$

[0038]
And the amendment count section 6 can perform correction by sensitiveness by applying the following -(1-3) (1-5) using these offset values Offsetx, Offsety, and Offsetz and the sensibility values Amplitudex, Amplitudey, and Amplitudez with cancellation of offset of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz.
Ynorm=(Y-Offsety)/Amplitudey ... (1-3)
Xnorm=(X-Offsetx)/Amplitudex ... (1-4)
Znorm=(X-Offsetz)/Amplitudez ... (1-5)
Drawing 2 is a flow chart which shows the calibration approach of the azimuth metering device concerning the 1st operation gestalt of this invention.
[0039]
In drawing 2 , the signal from the x-axis hall device HEx and the y-axis hall device HEy is acquired, placing the sensor module SM of drawing 1 horizontally (step S1), and making it rotate by a unit of 90 degrees in a horizontal plane (step S2 - S4).
And the renewal section 8 of correction value calculates the current offset values Offsetx and Offsety of the x-axis hall device HEx and the y-axis hall device HEy, and the sensibility values Amplitudex and Amplitudey, respectively by applying a formula (1-1) and (1-2) a formula (step S5).

[0040]
Next, the signal from the z-axis hall device HEz is acquired, placing the sensor module SM of drawing 1 perpendicularly (step S6), and making it rotate by a unit of 90 degrees centering on the direction of a vertical (step S7 - S9).
And the renewal section 8 of correction value calculates the current offset value Offsetz of the z-axis hall device HEz, and the sensibility value Amplitudez, respectively by applying a formula (1-1) and (1-2) a formula (step S10).
[0041]
It becomes possible to perform the calibration of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz with a sufficient precision, without it becoming unnecessary to rotate a mobile equipment at the rate of the fixed range, and being dependent on rotational speed by this, in order to compute the current FUSETTO values Offsetx, Offsety, and Offsetz of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, and the sensibility values Amplitudex, Amplitudey, and Amplitudez.
[0042]
Here, the case where a pocket device is rotated by a unit of 90 degrees from the azimuth theta of arbitration in XY flat surface is considered.
the signal from the x-axis hall device HEx when rotating the signal from the x-axis hall device HEx when rotating the signal from the x-axis hall device HEx by Xtheta, and rotating a pocket device only 90 degrees in XY flat surface in the azimuth theta of the arbitration before rotating a pocket device at theta+90 degrees of X, and rotating a pocket device only 180 degrees in XY flat surface -- ** -- if it carries out

$$X\theta = A_X \cdot \cos\theta + Offset_X$$
$$X\theta_{+180^\circ} = A_X \cdot \cos(\theta + 180^\circ) + Offset_X$$
$$= -A_X \cdot \cos\theta + Offset_X$$

であるから、

$$X\theta + X\theta_{+180^\circ} = (A_X \cdot \cos\theta + Offset_X)$$
$$+ (-A_X \cdot \cos\theta + Offset_X)$$
$$= 2 \cdot Offset_X$$

A next door and a formula (1-1) are obtained.
[0043] To this appearance

$$X\theta = A_X \cdot \cos\theta + Offset_X$$

とすると、

$$X\theta_{+90^\circ} = A_X \cdot \cos(\theta + 90^\circ) + Offset_X$$
$$= A_X \cdot \sin\theta + Offset_X$$

であるから、

$$(X\theta - Offset_X)^2 + (X\theta_{+90^\circ} - Offset_X)^2$$
$$= (A_X \cdot \cos\theta)^2 + (A_X \cdot \sin\theta)^2$$
$$= (A_X)^2$$

A next door and a formula (1-2) are obtained.
[0044]
For this reason, by rotating a pocket device in the direction of a right angle, and measuring only 5 times, it becomes possible to perform the calibration of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, respectively, and human being's sense of direction is used effectively and it becomes possible to mitigate the burden of the user at the time of doing a calibration activity.
[0045]
Drawing 3 is a flow chart which shows the calibration approach of the azimuth metering device concerning the 2nd operation gestalt of this invention.
In drawing 3 , the signal from the x-axis hall device HEx and the y-axis hall device HEy is acquired, placing the sensor module SM of drawing 1 horizontally (step S11), and making it rotate by a unit of 90 degrees in a horizontal plane (steps S12-S14).
[0046]
And the renewal section 8 of correction value calculates the current offset values Offsetx and Offsety of the x-axis hall device HEx and the y-axis hall device HEy, and the sensibility values Amplitudex and Amplitudey, respectively by applying a formula (2-1) and (2-2) a formula (step S15).
Next, the signal from the z-axis hall device HEz is acquired, placing the sensor module SM of drawing 1 perpendicularly (step S16), and making it rotate by a unit of 90 degrees centering on the direction of a vertical (steps S17-S19).
[0047]
And the renewal section 8 of correction value calculates the current offset value Offsetz of the z-axis hall device HEz, and the sensibility value Amplitudez, respectively by applying a formula (2-1) and (2-2) a formula (step S20).
Drawing 4 is a flow chart which shows the calibration approach of the azimuth metering device concerning the 3rd operation gestalt of this invention.
[0048]
In drawing 4 , the sensor module SM of drawing 1 is placed horizontally (step S41), and the signal from x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz is acquired (step S42).
Next, after rotating the sensor module SM in the direction (the inclination direction of the direction of a short hand of a pocket device) of eta only 90 degrees from a horizontal plane (step S43), the signal from the x-axis hall device HEx and the y-axis hall device HEy is acquired (step S44).
[0049]
Next, after rotating the sensor module SM in the direction (the inclination direction of the direction of a short hand of a pocket device) of eta only -90 degrees from a horizontal plane (step S45), the signal from the x-axis hall device HEx and the y-axis hall device HEy is acquired (step S46).
Next, after rotating the sensor module SM in the direction (the inclination direction of the longitudinal direction of a pocket device) of phi only 90 degrees from a horizontal plane (step S47), the signal from the z-axis hall device HEz is acquired (step S48).
[0050]
Next, after rotating the sensor module SM in the direction (the inclination direction of the longitudinal direction of a pocket device) of phi only -90 degrees from a horizontal plane (step S49), the signal from the z-axis hall device HEz is acquired (step S50).
And the renewal section 8 of correction value calculates the current offset values Offsetx, Offsety, and Offsetz of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, and the sensibility values Amplitudex, Amplitudey, and Amplitudez, respectively by applying a formula (2-1) and (2-2) a formula (step S51).
[0051]
It becomes possible by rotating a pocket device in the direction of a right angle, and measuring only 5

times by this, to perform the calibration of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, respectively.
Drawing 5 is a flow chart which shows the calibration approach of the azimuth metering device concerning the 4th operation gestalt of this invention.
[0052]
In drawing 5 , the sensor module SM of drawing 1 is placed horizontally (step 61), and the signal from x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz is acquired (step S62).
Next, after rotating the sensor module SM in the direction of phi only 180 degrees from a horizontal plane (step S63), the signal from the x-axis hall device HEx and the y-axis hall device HEy is acquired (step S64).
[0053]
Next, after rotating the sensor module SM in the direction of eta only 180 degrees from a horizontal plane (step S65), the signal from the z-axis hall device HEz is acquired (step S66).
And the renewal section 8 of correction value calculates the current offset values Offsetx, Offsety, and Offsetz of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz by applying a formula (2-1), respectively (step S67).
[0054]
It becomes possible by rotating a pocket device in the direction of a right angle, and measuring only 3 times by this, to perform the calibration of the offset values Offsetx, Offsety, and Offsetz of x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, respectively.
Drawing 6 is a flow chart which shows the calibration approach of the azimuth metering device concerning the 5th operation gestalt of this invention.
[0055]
In drawing 6 , the signal from the x-axis hall device HEx and the y-axis hall device HEy is acquired, placing the sensor module SM of drawing 1 horizontally (step S71), and making it rotate by a unit of 90 degrees in a horizontal plane (steps S72-S74).
And the renewal section 8 of correction value calculates the current offset values Offsetx and Offsety of the x-axis hall device HEx and the y-axis hall device HEy, and the sensibility values Amplitudex and Amplitudey, respectively by applying a formula (2-1) and (2-2) a formula (step S75).
[0056]
It becomes possible by rotating a pocket device in the direction of a right angle, and measuring only 3 times by this, to perform the calibration of the x-axis hall device HEx and the y-axis hall device HEy, respectively.
Drawing 7 is the block diagram showing the outline configuration of the azimuth metering device concerning the 6th operation gestalt of this invention.
[0057]
In drawing 7 , 3 shaft magnetometric sensor 11, the magnetometric sensor drive power supply section 12, the chopper section 13, the difference input amplifier 14, the A/D-conversion section 15, the amendment count section 16, the azimuth count section 17, the renewal section 18 of correction value, the correction value storage section 19, a display and control section 20, and a display 21 are formed in an azimuth metering device, and x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz are formed in 3 shaft magnetometric sensor 1.
[0058]
Here, the x-axis hall device HEx and the y-axis hall device HEy are arranged so that the angle of rotation within a horizontal plane may be detected, and the z-axis hall device HEz is arranged so that the angle of rotation within a vertical plane may be detected.
The chopper section 13 is for switching the terminal which drives x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz, respectively, and impresses the driver voltage outputted from the magnetometric sensor drive power supply section 12, respectively to x-axis hall device HEx, the y-axis hall device HEy, and the z-axis hall device HEz.

arranged at the Z direction for example.
Moreover, although the information only on the 2-way of north and the east may be used for a calibration, further, the information on the four directions of south and the west may be used for it, and, thereby, it can raise calibration precision.
[0073]
Moreover, you may make it use the information on four directions also about the calibration of the z-axis hall device HEz.
Moreover, although it can ask for both offset and a sensibility ratio in the calibration of the z-axis hall device HEz by standing to a vertical by the 2-way of north (or south) and the east (or west), when there is no calibration of a sensibility ratio the object for **, it may be made to perform the calibration of only offset by making it a vertical and measuring only in the one direction of east (or west).
[0074]
The top view showing the calibration approach of the azimuth metering device which drawing 12 requires for the 7th operation gestalt of this invention, and drawing 13 are flow charts which show the calibration approach of the azimuth metering device concerning the 7th operation gestalt of this invention.
It is equipped with the biaxial magnetometric sensor which sets a Y-axis as the X-axis and the direction of a short hand (longitudinal direction in the first display screen) for the longitudinal direction (the vertical direction in the first display screen) of a cellular phone in drawing 12 and 13.
[0075]
And a user pushes calibration initiation switch 34a, when the sense of the map of the present location currently displayed on the sense and display screen 33 of the actual scenery 31 of a its present location has shifted (step S101).
Next, it progresses to K1 of drawing 12 , and a display and control section 20 rotates the map currently displayed on the display screen 33 so that the east and west on the earth magnetism of the map currently displayed on the display screen 33 may be fit for right and left (Y shaft orientations) of the display screen 33 in consideration of the magnetic declination information on a their present location (step S102).
[0076]
Next, it progresses to K2 of drawing 12 , and a user pushes measurement carbon button 34b, after the sense of the map currently displayed on the display screen 33 turns the pocket device 32, looking at the actual scenery 31 of a its present location so that it may be in agreement with the sense of the actual scenery 31 of a its present location (step S103).
Next, it progresses to K3 of drawing 12 , and a display and control section 20 rotates the map currently displayed on the display screen 33 only 90 degrees so that the east and west on the earth magnetism of the map currently displayed on the display screen 33 may turn to the upper and lower sides (X shaft orientations) of the display screen 33 (step S104).
[0077]
Next, it progresses to K4 of drawing 12 , and a user pushes measurement carbon button 34b, after the sense of the map currently displayed on the display screen 33 turns the pocket device 32, looking at the actual scenery 31 of a its present location so that it may be in agreement with the sense of the actual scenery 31 of a its present location (step S105).
Next, it progresses to K5 of drawing 12 , and based on the signal from the x-axis hall device HEx outputted at the time of steps S103 and S105, and the y-axis hall device HEy, the renewal section 18 of correction value computes the offset value and sensibility value of the x-axis hall device HEx and the y-axis hall device HEy, respectively, and updates the offset value and sensibility value of the x-axis hall device HEx memorized by the correction value storage section 19 and the y-axis hall device HEy, respectively.
[0078]
And a user pushes calibration end-switch 34c, when the sense of the map of the present location currently displayed on the sense and the display screen 33 of the actual scenery 31 of a its present

location comes to be in agreement (step S106).
In addition, at step S103, since the y-axis hall device HEy becomes the east sense and an earth magnetism signal is set to 0, an offset value can be acquired from the output of the y-axis hall device HEy.
[0079]
Moreover, at step S103, since the x-axis hall device HEx becomes the north sense and an earth magnetism signal becomes max, amplitude value can be obtained from the output of the x-axis hall device HEx.
On the other hand, at step S105, since the y-axis hall device HEy becomes the north sense and an earth magnetism signal becomes max, amplitude value can be obtained from the output of the y-axis hall device HEy.
[0080]
Moreover, at step S105, since the x-axis hall device HEx becomes the east sense and an earth magnetism signal is set to 0, an offset value can be acquired from the output of the x-axis hall device HEx.
In addition, although the operation gestalt mentioned above explained on the assumption that the azimuth metering device was built into a pocket device, you may make it use this azimuth metering device for a pocket device, holding an azimuth metering device in the container which can be taken out and inserted (desorption) to pocket devices, such as PDA and a notebook computer, and equipping.
[0081]
For example, an azimuth metering device, its data-processing IC, Interface IC, etc. are established into the PCMCIA card inserted in the PC Card slot with which the notebook computer is equipped standardly, and you may make it incorporate the calibration function mentioned above as the driver.
It is specification mechanical [a PC Card slot] and electric, and since magnetic regulation have not been carried out about the magnetic-leakage-flux consistency inside a slot, the azimuth metering device formed into the general-purpose PCMCIA card cannot assume a magnetic-leakage-flux consistency in advance.
[0082]
when the stray magnetic field of a PC Card slot varies for every pocket device by incorporating the calibration function of an azimuth metering device into a PCMCIA card here, without it can amend offset of an azimuth metering device with a sufficient precision and is restricted to a specific pocket device -- about -- it becomes possible to use an angle metering device, equipping with it freely.
[0083]
In addition, you may make it make a PCMCIA card correspond to CF card slot, without making it carry a tilt-angle sensor, signal processing IC, an antenna of GPS, etc. together besides an azimuth metering device, and also restricting card format to a PCMCIA card.
[0084]
[Effect of the Invention]
It becomes possible to perform the calibration of a magnetometric sensor with a sufficient precision, without becoming possible [without rotating a mobile equipment at uniform velocity by collecting the outputs of a magnetometric sensor at intervals of predetermined rotation according to this invention, as explained above] to compute the current offset information on a magnetometric sensor, and being dependent on rotational speed.
[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the outline configuration of the azimuth metering device concerning the 1st operation gestalt of this invention.
[Drawing 2] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 1st operation gestalt of this invention.
[Drawing 3] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 2nd operation gestalt of this invention.
[Drawing 4] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 3rd operation gestalt of this invention.

[Drawing 5] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 4th operation gestalt of this invention.
[Drawing 6] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 5th operation gestalt of this invention.
[Drawing 7] It is the block diagram showing the outline configuration of the azimuth metering device concerning the 6th operation gestalt of this invention.
[Drawing 8] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 6th operation gestalt of this invention.
[Drawing 9] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 6th operation gestalt of this invention.
[Drawing 10] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 6th operation gestalt of this invention.
[Drawing 11] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 6th operation gestalt of this invention.
[Drawing 12] It is the top view showing the calibration approach of the azimuth metering device concerning the 7th operation gestalt of this invention.
[Drawing 13] It is the flow chart which shows the calibration approach of the azimuth metering device concerning the 7th operation gestalt of this invention.
[Drawing 14] It is the flow chart which shows the calibration approach of the conventional azimuth metering device.
[Description of Notations]
1 and 11 3 shaft magnetometric sensor
SM Sensor module
HEx X-axis hall device
HEy Y-axis hall device
HEz Z-axis hall device
2 12 Magnetometric sensor drive power supply section
3 13 Chopper section
4 14 Difference input amplifier
5 15 A/D-conversion section
6 16 Amendment count section
7 17 Azimuth count section
8 18 Renewal section of correction value
9 19 Correction value storage section
20 Display and Control Section
21, 33, and 43 Display
31 41 Scenery
32 42 Pocket device
34a and 44a Initiation switch
34b and 44b Measurement switch
34c and 44c End switch

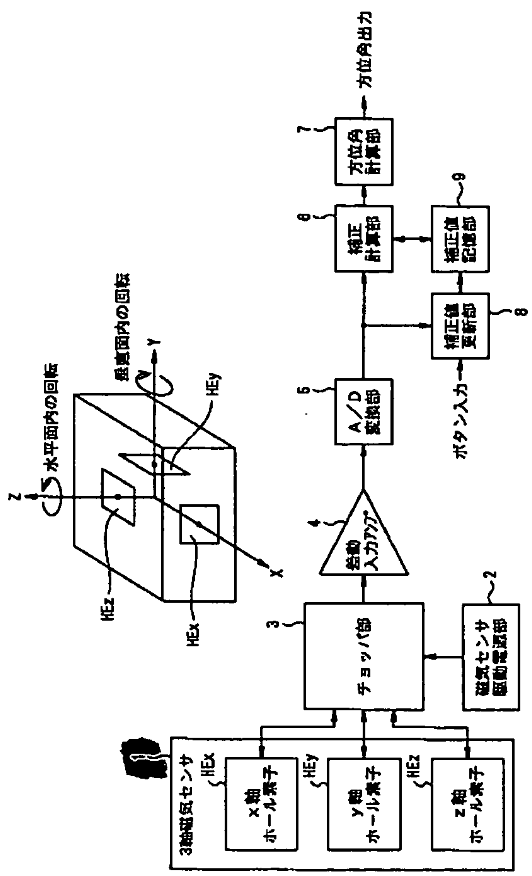
[Translation done.]

* NOTICES *

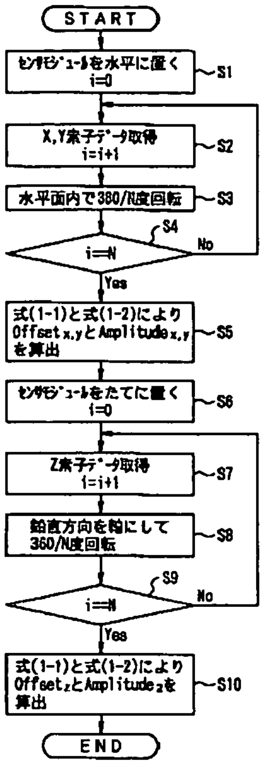
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

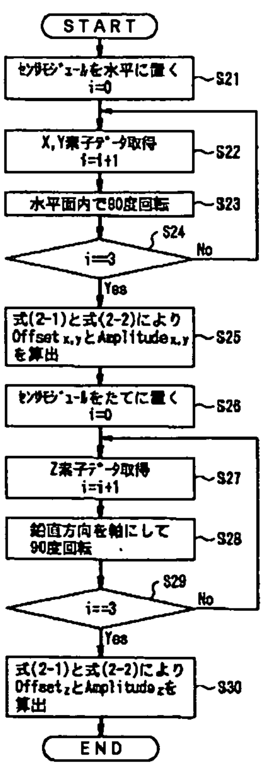
[Drawing 1]



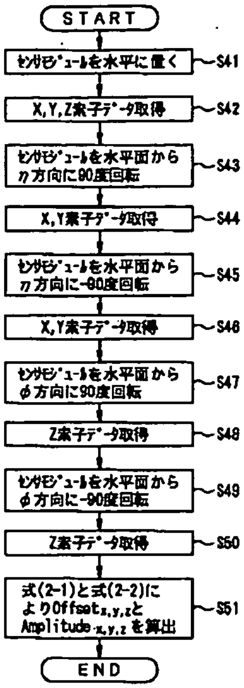
[Drawing 2]


START
ｾﾝｻﾓｼﾞｭｰﾙを水平に置く
i=0
S1
X,Y素子ﾃﾞｰﾀ取得
i=i+1
S2
水平面内で360/N度回転
S3
S4
i==N
No
Yes
式(1-1)と式(1-2)により
Offset x,yとAmplitude x,y
を算出
S5
ｾﾝｻﾓｼﾞｭｰﾙをたてに置く
i=0
S6
Z素子ﾃﾞｰﾀ取得
i=i+1
S7
鉛直方向を軸にして
360/N度回転
S8
S9
i==N
No
Yes
式(1-1)と式(1-2)により
Offset zとAmplitude zを
算出
S10
END

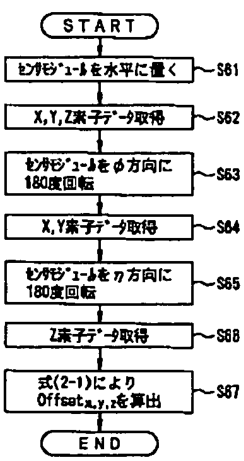
[Drawing 3]


START
ｾﾝｻﾓｼﾞｭｰﾙを水平に置く
i=0
S21
X,Y素子ﾃﾞｰﾀ取得
i=i+1
S22
水平面内で90度回転
S23
S24
i==3
No
Yes
式(2-1)と式(2-2)により
Offset x,yとAmplitude x,y
を算出
S25
ｾﾝｻﾓｼﾞｭｰﾙをたてに置く
i=0
S26
Z素子ﾃﾞｰﾀ取得
i=i+1
S27
鉛直方向を軸にして
90度回転
S28
S29
i==3
No
Yes
式(2-1)と式(2-2)により
Offset zとAmplitude zを
算出
S30
END

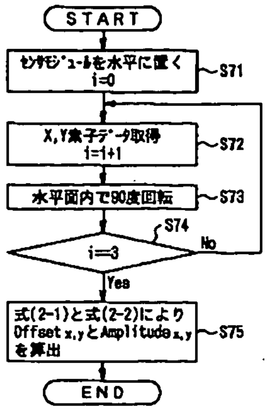
[Drawing 4]



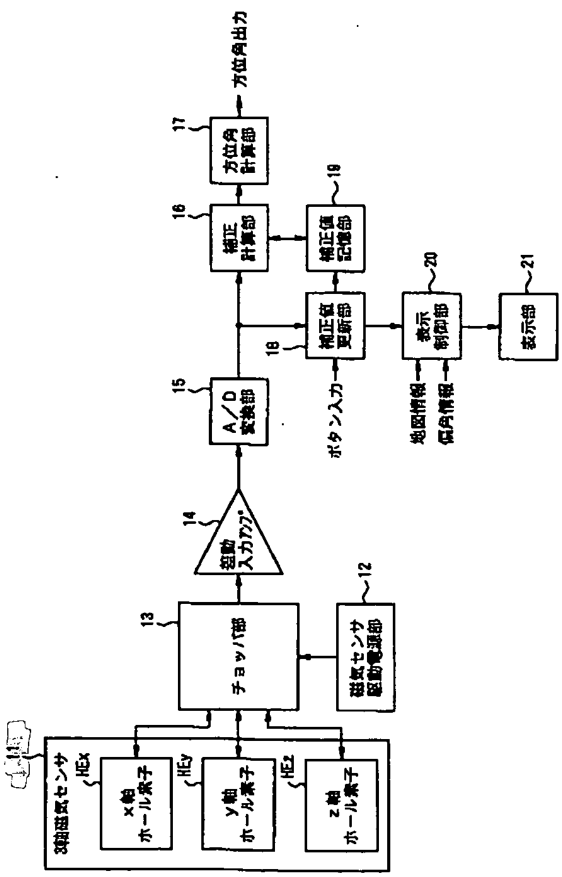
[Drawing 5]



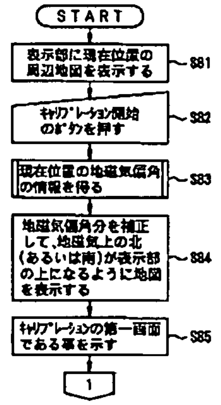
[Drawing 6]



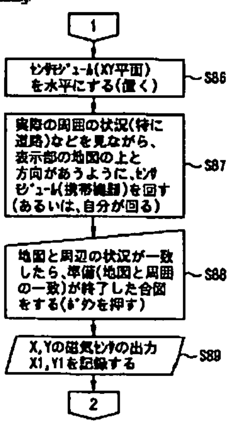
[Drawing 7]



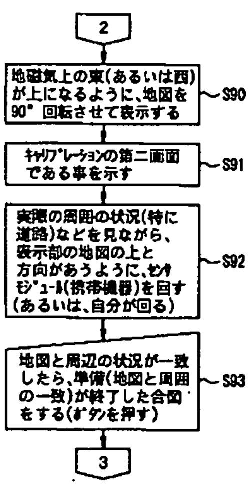
[Drawing 8]



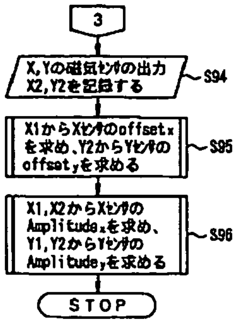
[Drawing 9]



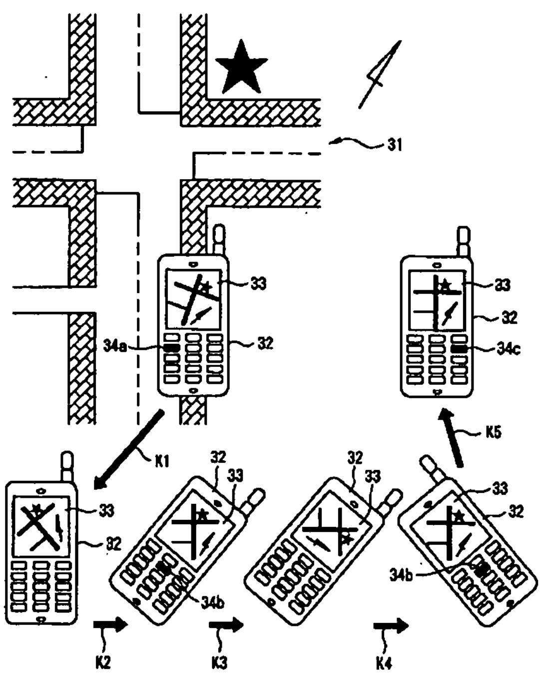
[Drawing 10]



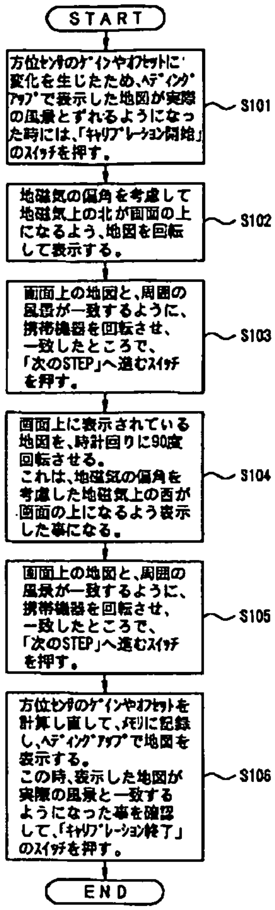
[Drawing 11]



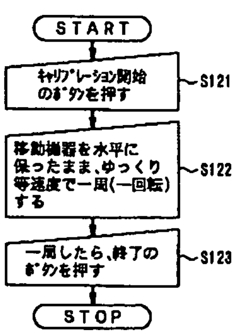
[Drawing 12]



[Drawing 13]



[Drawing 14]



[Translation done.]